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Orientador: Dr. Paulo Jorge de Morais Zamith Nicola

Dissertação especialmente elaborada para obtenção do grau de Mestre em Epidemiologia

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A impressão desta dissertação foi aprovada pelo Conselho Científico da Faculdade de Medicina de Lisboa em reunião de 17 de Setembro de 2019.

Em memória do meu Pai, Carlos Figueira Martins.

Resumo

Enquadramento: A atividade física (AF) e o comportamento sedentário são dois importantes e distintos fatores de risco modificáveis que influenciam a saúde. Apesar dos benefícios para a saúde, estima-se que um em cada quatro adultos não cumpra com os 150 minutos de atividade física com intensidade moderada a vigorosa recomendados pela Organização Mundial da Saúde. Por outro lado, apesar dos malefícios, a prevalência do comportamento sedentário é elevada na população adulta. Estudos que adotem uma análise conjunta dos fatores de risco relacionados com a AF e o tempo passado sentado (TS) podem ser mais informativos do ponto de vista da prevenção e da promoção da saúde. Uma vez que diversos tipos de comportamentos associados à atividade física e ao comportamento sedentário são adotados diariamente pelos adultos, é necessário compreender melhor os subgrupos populacionais que, pela combinação destes comportamentos, apresentam um perfil de risco. Assim, o presente estudo tem como objetivo identificar os correlatos sociodemográficos da AF, do TS e dos grupos resultantes da combinação da AF com o TS numa amostra nacional e representativa de adultos Portugueses.

Métodos: Este estudo tem um desenho observacional e transversal, e foi realizado com informação recolhida no Inquérito Nacional Alimentar e de Atividade Física (IAN-AF 2015-2016). O IAN-AF permitiu a criação de uma base de dados de representatividade nacional sobre três grandes domínios: alimentação e nutrição, o estado nutricional e a AF. O IAN-AF envolveu a população residente em Portugal, com idades compreendidas entre os 3 e 84 anos de idade.

Os participantes foram selecionados por um processo de uma amostragem complexa bietápica, a partir do Registo Nacional de Utentes do Serviço Nacional de Saúde. No presente estudo foram incluídos 1724 adultos (50.5% mulheres, 49.5% homens), com idades

compreendidas entre os 18 e os 64 anos. Os participantes foram entrevistados presencialmente, sendo que a recolha de informação da AF e do TS teve por base a versão curta do *International Physical Activity Questionnaire (IPAQ*). Simultaneamente foi recolhida informação sociodemográfica: sexo, idade, estado marital, habilitações literárias, situação profissional, rendimento mensal do agregado familiar, entre outros.

Tendo por base a conjugação de categorias referentes às combinações de AF e do TS, os adultos foram classificados nos seguintes grupos: AF elevada / TS reduzido; AF elevada / TS elevado; AF reduzida / TS reduzido; AF reduzida / TS elevado. AF elevada e AF reduzida corresponde às categorias extremas do IPAQ: 'pouco ativo' e 'ativo'. TS reduzido e TS elevado correspondem, respetivamente, ao 1º tercil (≤ 180 minutos por dia) e ao 3º tercil (≥ 360 minutos por dia). Os adultos classificados nas categorias intermédias como 'moderadamente ativos' ou no 2º tercíl de TS não foram incluídos neste estudo, pretendendo-se apenas uma análise dos perfis referentes às categorias extremas.

A análise estatística com modelos de regressão logística permitiu identificar os fatores sociodemográficos associados a ser fisicamente ativo, ao elevado TS (≥ 360 minutos) e aos diferentes perfis decorrentes da combinação entre a AF e TS (AF elevada/TS reduzido; AF elevada/TS elevado; AF reduzida/TS reduzido; AF reduzida/TS elevado). As estimativas decorrentes das análises estatísticas foram todas ponderadas à população Portuguesa e conduzidas no software estatístico IBM SPSS versão 24.0. O nível de significância foi fixado em 0,05. O projeto IAN-AF recebeu autorização ética das autoridades de saúde regionais. O projeto desta tese também foi submetido e aprovado pela Comissão de Ética do Centro Académico de Medicina de Lisboa (CAML /FMUL /IMM).

Resultados: Dos 1724 adultos participantes, após exclusão dos tercis intermédios de AF e de TS, mais de metade (57.9%) foram classificados como tendo um estilo de vida ativo (categoria "ativo" do IPAQ). Os restantes adultos foram considerados fisicamente inativos

(categoria “pouco ativo” do IPAQ). Quanto ao TS, 46.88% dos adultos gastavam pouco tempo (180 minutos por dia) e 53.2% gastavam muito tempo (≥ 360 minutos por dia). A partir da interseção das diferentes categorias de AF e TS, verificou-se que 37.3% apresentava um perfil de baixa AF e elevado TS (perfil de maior risco) e 26.6% dos adultos uma elevada AF e baixo TS (perfil de menor risco).

No que concerne aos fatores associados com a AF, a partir do modelo ajustado constatou-se que ser solteiro comparativamente a ser casado [Odds Ratio (OR) = 1.48, Intervalo de Confiança, (IC): 1.07-2.07], ter 25-34 anos (OR = 1.81, 95% IC: 1.20-2.73) e 35-44 anos (OR = 1.66, 95% IC: 1.16-2.36), em relação a ter 18-25 anos, estava a positivamente associado a ser fisicamente ativo, enquanto ter um nível educacional médio estava negativamente associado quando comparado a ter um nível educacional baixo. Quanto aos fatores associados ao TS , os adultos que tinham entre 35 e 44 anos (OR = 0.41, 95% IC: 0.27-0.61), 45 e 54 anos (OR = 0.45, 95% IC: 0.25-0.80), e entre 55 e 64 anos (OR = 0.62, 95% IC: 0.41-0.94) tinham todos menores probabilidades de despenderem um elevado TS quando comparado com ter 18-25 anos. Contrariamente, os adultos com 12 anos de escolaridade (OR = 2.70, 95% IC: 1.87-3.89) ou mais anos (OR = 3.67, IC: 2.19-6.15), e aqueles com um estatuto socioecónomico médio (OR = 1.64, 95% CI: 1.12-2.40) e elevado (OR = 1.84, 95% IC: 1.16-2.91), tinham maior probabilidade de despenderem mais de 360 minutos por dia sentados.

Segundo o modelo ajustado, ter um perfil socioeconómico médio (OR = 1.50, IC: 1.07-2.11), o ensino secundário (OR = 2.59, IC: 1.76-3.84) ou superior (OR = 2.59, IC: 1.76-3.84) e não ter idades compreendidas entre os 25-34 (OR = 0.46, IC: 0.28-0.75) e 35-44 (OR = 0.57, IC: 0.28-0.75) anos estava associado a integrar o grupo com pior risco (fisicamente inativo e elevado tempo TS). Ter 18-24 ou 25-34 anos, ser homem (OR = 1.96, IC: 1.33-2.90) e ter um nível educacional elevado (OR = 1.86, IC: 1.14-3.03) estava associado a cumprir

com as recomendações de AF mas simultaneamente a passar largos períodos de tempo sentado. Ter mais do que o 12º ano (OR = 0.46, IC: 0.27-0.79) e ser solteiro (OR = 0.49, IC: 0.29-0.84) surgiu inversamente associado ao perfil "reduzida AF / elevado TS". Os adultos com idades compreendidas entre os 25-34 (OR = 1.83, IC: 1.08-3.10) e 35-44 anos (OR = 2.10, CI: 1.42-3.10), e com um baixo nível educacional, tinham maior probabilidade de estar no grupo com um perfil de risco mias favorável, isto é, ser fisicamente ativo e passar pouco tempo sentado.

Discussão: O presente estudo permitiu identificar subgrupos da população que, devido à conjugação dos comportamentos de AF e TS, apresentam potencialmente diferentes níveis de risco para a sua saúde. O grupo que com um perfil menos favorável (AF reduzida / TS elevado) caraterizava-se por ser composto por adultos que tendencialmente reportaram ter um estatuto socioeconómico médio, o ensino secundário ou superior e idades não compreendidas entre os 25 e 44 anos. Numa fase inicial, pode ser importante promover junto deste grupo a quebra do tempo que passam sentados e potenciar o seu envolvimento em atividades físicas de intensidade leve. A mudança de comportamento associada à transição de tempo sentado para atividade física leve pode ser mais suave e realista do que comparada com a mudança necessária para cumprir com as recomendações de atividade física, que envolvem intensidades moderadas e vigorosas. Ser jovem adulto (18-34), homem e ter um nível educacional elevado estava associado a cumprir com as recomendações de atividade física mas simultaneamente a passar largos períodos de tempo sentado. As mensagens dirigidas para este grupo podem enfatizar a importância de se reduzir o tempo passado sentado e de adotar mais frequentemente comportamentos associados a uma atividade física de intensidade leve. Os adultos com idades compreendidas entre os 25 e 44 anos, e com um baixo nível educacional, tinham maior probabilidade de integrar o grupo mais favorável, isto é, fisicamente ativo e pouco tempo sentado.

Conclusão: Numa perspetiva de saúde pública, as futuras campanhas de comunicação e de intervenção devem ser direcionadas para os diversos perfis resultantes da combinação da atividade física e do comportamento sedentário.

Palavras-chave: Comportamentos saudáveis, atividade física, comportamento sedentário, correlatos, inquérito nacional.

Abstract

Purpose: To identify the socio-demographic correlates of the physical activity (PA), sitting time (ST) and of combined PA-ST patterns in a nationally representative sample of Portuguese adults. **Methods:** Data from a national survey on diet and activity behaviors (National Food, Nutrition and Physical Activity Survey, IAN-AF, 2015– 2016) was used, with 1724 adults (50.5% women, 49.5% men, 18-64 years) included in this study. Participants were interviewed face to face, and the short form of the International PA questionnaire (IPAQ) was used. Logistic regression models examined the relationship between PA, ST and each PA/ST pattern group (high PA/low ST, high PA/high ST, low PA/low ST, low PA/low ST) with socio-demographic correlates. Low PA and high PA represent the low and high categories of IPAQ. Low and high ST corresponded to the 1st tercile (≤180min/day) and 3rd tercile (≥360 min/day). All statistics were weighted according to a complex sampling design with *p* set at 0.05. **Results:** 37.5% of the adults revealed to have a 'higher risk' behaviour pattern (low PA/high ST). They tended to have a middle socioeconomic status, 12 or more years of education, and not to be middle aged (25-44 years). The 'lower risk' group represented 26.3% of the sample and included mainly middle-aged adults with a lower educational level. Being male, young and highly educated was related with adopting both high PA and ST. **Conclusion:** From a public health perspective, future messages and interventions may need to be tailored to specific profiles of PA/ST.

Keywords: Health behaviours, physical activity, sedentary behaviour, correlates, national survey.

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1. Preamble

My interest in the study developed in this thesis has a strong personal and professional context. I love to teach and research. In 2008, I obtained a first degree (pre-Bologna 5-years degree) in Sports Sciences. I have also obtained post-graduation in Data Analysis in Social Sciences in 2011 and a master's degree in Teaching physical Education in Primary and Secondary Schools in 2012. In 2015, I completed a PhD in Educational Sciences, speciality of didactics of Physical Education and Sport. Since 2011, I teach in a higher education context subjects related to education, pedagogy, physical education and physical activity, and research methods. My main research interests have been mainly related with the understanding of how physical education and schools can increase their role in promoting active and healthy lifestyles throughout life (Martins, Anacleto, et al., 2018; Martins, Marques, et al., 2018; Martins, Marques, Sarmento, & Carreiro da Costa, 2015). Identifying the relationship between PA and health and the PA determinants has also been a research focus (A. Marques, Peralta, et al., 2016; A. Marques, Peralta, et al., 2018; Martins, Marques, et al., 2019; Martins, Marques, Peralta, Palmeira, & Carreiro da Costa, 2017). Thus, my teaching and research profile intersects the main areas of education, sport sciences and health. However, I felt that my knowledge and competences concerning health and epidemiology needed to be improved.

I choose to do this master in order to improve my understanding, knowledge and competences in developing and conducting research projects in health sciences and epidemiology. I wanted to develop knowledge concerning certain types of studies, such as surveys, cohort, randomized control trials and systematic reviews. Moreover, collaborating with distinct professionals, developing a multi-disciplinary approach and doing quality research were also important purposes for choosing this master.

During my journey in this master, I had the opportunity to lead colleagues for developing a research project tilted "*O que praticam e quais os conhecimentos das recomedações dos estudantes do ensino superior em Portugal*? [Physical activity levels and knowledge of physical activity recommendations of Portuguese university students?]" under the supervision of Dr. Paulo Nicola. This was an applied way to develop my knowledge and skills concerning the development of epidemiological research projects to be submitted to competitive funding. This project was submitted to the Instituto Português do Desporto e da Juventude (IPDJ), in a competitive funding process. The pilot study of this project was implemented, a paper developed and published (Martins, Cabral, et al., 2019), and presented in an international congress of public health (Cabral et al., 2018).

Since 2017, I am leading the evaluation and intervention on physical activity and physical education in the '*Sintra Cresce Saudável: Programa de promoção de estilos de vida ativos e saudável em contexto escolar*'. This project involves several partners: Município de Sintra, two school groups from Sintra, Escola superior de Comunicação Social, Escola Superior de Saúde e Tecnologia de Lisboa, Faculdade de Medicina, and Faculdade de Motricidade Humana. I have been leading the team of researchers from Faculdade de Motricidade Humana concerning the dimension of physical activity evaluation and its promotion in primary school students (aged between 6 and 10 years). This project was submitted for obtaining funding at Fundaççção Calouste Gulbenkian, and presented in one international Sport Sciences congress (Martins, 2018).

For the thesis, I sought to improve my knowledge and competences concerning a theme that involves health, a relatively new approach of working with the physical activity and sedentary behaviour concepts, the analysis of a national survey, and evidence-based information that might be of value for public health policies. The opportunity to do it arouse from the National Food, Nutrition and Physical Activity Survey, 2015-2016 (Portuguese

acronym: IAN-AF 2015-2016 Survey, Inquérito Alimentar Nacional e de Atividade Física; www.ian-af.up.pt). The IAN-AF collected nationwide data on dietary and physical activity habits, and their health determinants.

The present thesis was developed at the Unidade de Epidemiologia do Instituto de Medicina Preventiva e Saúde Pública da Faculdade de Medicina de Lisboa, one element of the IAN-AF consortium. The IAN-AF consortium is composed from researchers from several national and non-national institutions, namely: the University of Porto (Promoter), the National Institute of Health (INSA), the University of Lisbon, the University of Oslo, Norway and the enterprise SilicoLife. The IAN-AF collected nationwide data on dietary and physical activity habits, and their health determinants.

The team that developed this study was composed by me (João Martins), Paulo Nicola, Pedro Teixeira and Jorge Mota, for the IAN-AF consortium. I was responsible for the conception and design of the study, data analysis and interpretation, and drafting the manuscript. The data acquisition was responsibility of the IAN-AF consortium, with the PA dimension being directed by Pedro Teixeira and Jorge Mota. Pedro Teixeira and Jorge Mota give their assent to the abstract of the project and were be invited to critically revise the intellectual content of the study. Paulo Nicola contributed to and supervised all phases of the study.

The development of the study included in this thesis was a long and a highly iterative process. The purpose of the study included in this master thesis is slightly distinct from the one initially purposed. Along the way, several hypotheses have been explored, involving many hours of (invisible) work, reading, doing statistical analysis, and critical reflections with the supervisor, experts, and different professionals in two scientific public sessions (January 2018 and November 2018). The study presented in this thesis sought to identify the socio-

demographic correlates of PA, sitting time (ST) and of PA-ST groups considering a nationally representative sample of Portuguese adults.

As for the acknowledgements, the IAN-AF survey had institutional support from the General Directorate of Health (DGS), the Regional Health Administration Departments, the Central Administration of the Health System (ACSS), and from the European Food Safety Authority (CFT/EFSA/DCM/2012/01-C03). All these institutions and persons involved in all phases of the Survey, as well as participants, are acknowledgeable. The IAN-AF 2015-2016 Survey has received funding from the EEA Grants Program, Public Health Initiatives (PT06 - 000088SI3). I do thank to the IAN-AF Consortium institutions and researchers for the opportunity and support provided for developing the present study and master thesis.

The present thesis will be composed by one article, with the same title as the thesis, involving the following sections: introduction, methods, results, discussion and conclusion.

2. Article

"Socio-demographic correlates of physical activity and sitting time patterns in adults: an analysis with the Portuguese Food, Nutrition and Physical Activity Survey"

2.1. Introduction

Physical activity (PA) is an important modifiable lifestyle risk factor (USDHHS, 2018; Warburton & Bredin, 2017; WHO, 2014). Regular PA is associated with health benefits, such as the reduction in the risk of coronary heart disease, stroke, type 2 diabetes, high blood pressure, dementia and excessive weight gain (I. Lee et al., 2012; USDHHS, 2018; Warburton & Bredin, 2017). Moreover, physically active adults sleep, feel and function better, and have better quality of life (A. Marques, Peralta, et al., 2016; USDHHS, 2018).

However, worldwide many adults are physically inactive and do not meet the PA recommendations (Guthold, Stevens, Riley, & Bull, 2018; Hallal et al., 2012; A. Marques, Sarmento, Martins, & Saboga-Nunes, 2015; Sallis et al., 2016; WHO, 2010). It is estimated that the global prevalence of physical inactivity in adults has increased in high income-countries from 31.6% in 2001 to 36.8% in 2016 (Guthold et al., 2018). In Portugal, the prevalence of physical inactivity in a representative sample of adult population was about 35% (A. Marques et al., 2015) and 30% (Baptista et al., 2012), considering self-reported and objective data obtained by accelerometry. In addition to morbidity and mortality (I. Lee et al., 2012), the pandemic of physical inactivity is responsible for a substantial economic burden (Ding et al., 2016). Therefore, efforts to promote PA urge and have been recommended has a 'best buy' strategy for the prevention and control of non-communicable diseases (DGS, 2017; WHO, 2014, 2017).

During the last decade, a rapidly and growing body of evidence has been focusing on sedentary behaviour (SB) as a public health issue (Jochem, Schmid, & Leitzmann, 2018; Stamatakis et al., 2018; Tremblay et al., 2017). SB can be defined as any waking behaviour characterized by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture (Tremblay et al., 2017). Total sitting time (ST) has been often used as a specific marker of SB during waking hours (Bauman et al., 2011; Tremblay et al., 2017). ST is high prevalent in adult population of high-income countries (Bauman, Petersen, Blond, Rangul, & Hardy, 2018; Loyen, van der Ploeg, Bauman, Brug, & Lakerveld, 2016; Loyen, Verloigne, et al., 2016). By analysing 39 large and population-based studies published between 2012 and 2016 it was found that the median self-report of ST for adults was 5.5 h/day (Bauman et al., 2018). Trends data shows that between 2002 and 2013 the problem is not increasing (Bauman et al., 2018; Milton, Gale, Stamatakis, & Bauman, 2015) but that between a third and two-thirds are in the 'high sitting' or 'at-risk' level (Bauman et al., 2018; Loyen, van der Ploeg, et al., 2016). Exposure to high amounts of SB, and particularly ST, significantly increases the risk of all-cause mortality, cardiovascular disease incidence and mortality, and type 2 diabetes (Biswas et al., 2015; Ekelund et al., 2016; Owen, 2017; USDHHS, 2018), often independently of PA (Bennie et al., 2013; Biswas & Alter, 2015; Chau et al., 2013).

While further research is needed to determine the independent and interactive effects of PA and SB on multiple health outcomes in adults (Schmid, Ricci, & Leitzmann, 2015; Stamatakis et al., 2018; Thompson, Peacock, Western, & Batterham, 2015; USDHHS, 2018), it is becoming clearer that SB and PA represent two different constructs, appearing to have specific correlates (Bauman et al., 2012; Loyen, van der Ploeg, et al., 2016). In course of the day it is possible to accumulate both behaviours, such as meeting the MVPA recommendations and spending 10 or more hours of the day sitting (Engelen et al., 2017;

Thompson et al., 2015). Some studies have already started to explore the effect of combined associations between categories of PA and SB on health outcomes (Bakrania et al., 2016; Ekelund et al., 2016; Engelen et al., 2017; Loprinzi, Lee, & Cardinal, 2014; A. Marques, Santos, Peralta, Sardinha, & Gonzalez Valeiro, 2018). In general, the low PA and high sit adult profile was associated with worse health and mortality indicators, such as higher cardiovascular disease risk (Chomistek et al., 2013; Maddison et al., 2016), cardio-metabolic risk markers (Bakrania et al., 2016; Chau et al., 2013; Engelen et al., 2017; Loprinzi et al., 2014; Schmid et al., 2015), and all-cause mortality risk (Chau et al., 2013; Schmid et al., 2015). Simultaneously, these studies also provide evidence that adults with lower level of ST and higher levels of PA had the healthiest profile.

Because adults may engage, during their lifetime, in different combination of both behaviors in their everyday life, it is crucial to understand whether these behavior specific groups may be easily identified. This would have implications for research, intervention and policy actions (Ekelund et al., 2016; Jochem et al., 2018; Loyen et al., 2017; Thompson et al., 2015; USDHHS, 2018). Current evidence on the factors associated with combined PA and ST patterns is limited (Ekelund et al., 2016; Loyen et al., 2017). Further research on the socio-demographic correlates of combined PA and ST is warranted and can help identify the sub-groups of the population at risk, which could then be targeted in interventions (Chau et al., 2013; Jochem et al., 2018; Loyen et al., 2017). Therefore, considering a nationally representative sample of Portuguese adults, the present study sought to identify the socio-demographic correlates of the PA, ST and of PA-ST patterns.

2.2. Methods

2.2.1. Study design, sample and procedures

The IAN-AF Survey of the Portuguese general population aimed to collect nationwide data on dietary habits and physical activity and their relation with health determinants. The IAN-AF Survey was conducted by a consortium, involving researchers from the University of Porto, the National Institute of Health (INSA), the University of Lisbon, the University of Oslo and the enterprise SilicoLife. More detailed information on design and methods of the IAN-AF survey is presented elsewhere (Lopes et al., 2018; www.ian-af.up.pt)

A representative sample of the Portuguese population, aged between three months to 84 years of age was selected from the National Heath Registry by multistage sampling in each of the seven Portuguese geographical regions (NUTS II: North, Centre, Lisbon Metropolitan Area, Alentejo, Algarve, Madeira and Azores), and weighed according to sex and age group. Individuals with the following criteria were excluded: i) living in collective residences or institutions, ii) living in Portugal for less than one year (non-applicable to infants), iii) non-Portuguese speakers, iv) with diminished physical and/or cognitive abilities that hampered participation, and v) deceased. The IAN-AF is a cross sectional study and included a sample of 3445 adults (18-64 years old) who completed the first interview. Trained health professionals fieldworkers, using computer-assisted personal interviewing collected data, from October 2015 to September 2016. A considerable number of interview registries in all the weekdays and seasons were assured (Lopes et al., 2018).

The present cross-sectional study is based on the data from the IAN-AF, but only included those participants: i) with no Parkinson disease, ii) classified in the low or the high category of the International Physical Activity Questionnaire (IPAQ), and not the moderate category, and iii) classified in the first (low sit) or third tercile (high sit) of sitting time, and not the second tercile. Therefore, of the 3445 adults, four were excluded from the analysis

because they have been diagnosed with Parkinson. A total of 3251 adults had also data for computing a total PA score [Median = 1386 MET-min/week, Interquartile range (IQR) = 2751 Met-min/week] and, based on IPAQ procedures (www.ipaq.ki.se), were classified in three PA categories: low (n = 1135, 39.6%, weighted % 40.7), moderate (n = 885, 27.2%, weighted % 28.2) and high (n = 1000, 30.2%, weighted % 31.1). Moreover, 3349 adults had valid data regarding the siting time (median = 300 min/day; interquartile range (IQR) = 240 min / day). Based on terciles, the following categories of ST were obtained: low (≤180min/day, n = 1178, 35.2%; weighted % 36.0), moderate (181-359 min/day, n = 885, 26.4%, weighted % 25.3) and high (≥360 min/day, n = 1286, 38.4%, weighted % 38.7). Those adults classified with a moderate ST or PA level were excluded from the analysis. Considering that only those adults that were in the extreme categories of PA and ST were included in the present study, the final sample was composed by 1724 adults (50.5% women, 49.5% men).

Ethical approval for the conduction of the IAN-AF was obtained from the National Commission for Data Protection, the Ethical Committee of the Institute of Public Health, University of Porto and from the Ethical Commissions of the Regional Administrations of Health. All participants were asked to provide their written informed consent for participation according to the Ethical Principles for Medical Research involving human subjects expressed in the Declaration of Helsinki and the national legislation. Additionally, the master thesis project received Ethical approval from the Comissão de Ética do Centro Académico de Medicina de Lisboa (CAML/FMUL/IMM).

2.2.2. Measures

Socio-demographics characteristics

The following socio-demographic variables were assessed: 1) sex, 2) age, 3) level of education, 4) working conditions, 5) marital status, 5) monthly household income, and 6)

household size. The following age groups were made: 18-24, 25-34, 35-44, 45-54 and 55-64 years old. The higher educational level concluded was asked to each participant. Response options were: No schooling, 1st cycle of basic education (4 years), 2nd cycle (6 years), 3rd cycle (9 years), secondary (12 years), post secondary non superior (e.g. professional course) and superior (university degree). These categories were grouped to create three new groups of educational level: low (≤ 9 years of education), middle (12 years), and high (> 12 years). As for the current working conditions the participants had three options: working, unemployed and other. The 'Other' category includes retired, students, domestic, in military service, widow's pension, survivor's pension, unpaid leave and no retirement. Participants were asked to describe marital status: single, divorced, widower, and married or common-law marriage. Given the low count on some classes, the answers were reorganized into three categories: married or common-law marriage, single and other (divorced and widower). Household monthly income after tax and obligatory deductions, from all sources, was asked to participants. Several response options were available. Using this data, 1st to 3rd, 4th to 7th, and 8th to 10th decile were identified to create three groups: low (corresponding to < 970€), middle (corresponding to 971€-1940€) and high (> 1941€). Participants reported the number of people living regularly as a member of the household.

Physical activity

PA was assessed using the short form of the International Physical Activity Questionnaire (IPAQ). The PA assessment with IPAQ has been shown to have acceptable reliability and validity for the Portuguese population (Craig et al., 2003). Participants were asked about duration (minutes) and frequency (days) of walking, moderate intensity activities and vigorous intensity activities. By using established methods posted on the IPAQ website (www.ipaq.ki.se), a combined total PA score was created. Then, four continuous scores of PA were computed to be present in MET-Minutes/Week. Afterwards, based on the IPAQ

protocol, three levels of PA were proposed to classify the population: low, moderate and high. In the 'high' category are people who report at least one hour per day or more of at least moderate-intensity activity (i.e. individuals achieved at least 3000 MET-Minutes/Week). The moderate category represents a level of activity equivalent to half an hour of at least moderate-intensity PA on most days (i.e. at least 600 MET-Minutes/Week). The 'low' category includes those adults who not meet criteria for previous categories.

Sitting time

ST was measured with the following IPAQ question: *During the last 7 days, how much time did you usually spend sitting on a weekday?* Participants were asked to consider multiple life domains for the period of ST being recalled. The weekday was chosen to reflect habitual behaviour. Responses were expressed in minutes per day. This question has been identified to have acceptable reliability and validity for assessing usual sitting time (Craig, 2003; Rosenberg, 2008). Considering that there are not yet clear guidelines of sedentary behaviour for health (USDHHS, 2018), 1st to 3rd, 4th to 7th, and 8th to 10th decile were identified to create three groups: low sit (≤180min/day), moderate sit (181-359 min/day) and high sit (≥360 min/day).

Physical activity and sitting time patterns

Adults classified in the low or high PA category, and in the low (1st tercile) or high ST (3rd tercile) were included in the study. Thus, adults in the moderate PA category or in the 2nd tercile of ST were excluded from the study. Considering the overestimation associated with self-reported PA (A. Marques, Martins, Ramos, Yazigi, & Carreiro da Costa, 2014; Sallis & Saelens, 2000) and the fact that the IPAQ short form evaluates full daily PA, only adults in this higher category have higher odds of meeting the PA recommend guidelines (P. Lee, Macfarlane, Lam, & Stewart, 2011; WHO, 2010). On the other hand, those in the low category had a very low PA level. Moreover, given the fact that there is no clear sedentary

behaviour guidelines (USDHHS, 2018) and that the levels of ST in the adult population are mainly high (Loyen, van der Ploeg, et al., 2016; Loyen, Verloigne, et al., 2016), a data-driven approach was undertaken to classify individuals in three categories of ST, based on terciles (Rosenberg, Bull, Marshall, Sallis, & Bauman, 2008). Therefore, using these classifications, participants were grouped into one of four PA-ST groups: 1) high PA/low sit; 2) high PA/high sit; 3) low PA/low sit; and 4) low PA/high sit. Choosing adults in the lower and upper categories of PA and ST allowed to have a clearer contrast between PA-ST profiles, and was feasible due to the sample size.

2.2.3. Data analysis

Descriptive statistics were calculated (means, standard deviation and percentages) to characterize the entire sample (non-weighted and weighted estimates; table 1) and each PA-ST group (table 2). One-way ANOVA and Chi-square test for complex samples were used to compare the four PA-ST groups according to socio-demographics characteristics (table 2). Binomial logistic regression models were conducted separately to examine the potential association between socio-demographic variables and PA level (having high PA as the reference category), or ST (having high ST as the reference category). First, an unadjusted model was performed (Table 3, Model 1). Afterwards, multivariate regression models were built considering all other socio-economic variables with $p < 0.2$ (Table 3, Model 2). To examine the effects that socio-demographics had on each of the four PA-ST combined groups, logistic regression models were examined. Unadjusted analyses (Table 4, Model 1) followed by analyses adjusted for those socio-demographic variables with $p < 0.2$ (Table 4, Model 2) were conducted for each of the four PA-ST combined groups. For all models, odds ratio (OR) with 95% confidence intervals (CI) were calculated. All statistics were weighted according to a complex sampling design, considering stratification by seven geographical regions and cluster effect for the selected Primary Health Care Unit. Further details on the

complex sample procedures can be found elsewhere (IAN-AF, 2019). All statistical analyses were performed using IBM SPSS Statistics 24.0 (New York City, USA). The significance level assumed for statistical inference was set at $p < 0.05$.

2.3. Results

The socio-demographic characteristics of the adults included in the final sample are presented in table 1. Based on the weighted percentage estimates, the majority of the adults were workers (70.9%), married (59.6%), had a low education level (45.2%) and were 35 to 54 (52%) years old. More than half of the participants were classified as physically inactive (57.9%) and spending more that 360 minutes per day in ST (53.2%). The combination of the PA groups with the ST groups allowed having four PA-ST groups. The low PA/high sit group (37.3%) had more adults.

Table 1. Socio-demographic characteristics of adults included in the final sample and weighted sample estimates.

	Sample % (n)	**Weighted sample**	
		Weighted % (95% CI)	$\widehat{N}$
Sex			
Female	50.5 (871)	46.1 (43.4-48.7)	1.674.999
Male	49.5 (853)	53.9 (51.3-56.5)	1.961.538
Age			
18-24	13.3 (230)	13.2 (10.8, 16.0)	480.001
25-34	18.9 (326)	17.2 (15.0-19.7)	625.344
35-44	26.2 (451)	27.5 (24.6-30.5)	999.166
45-54	23.1 (398)	24.5 (21.4-27.9)	892.032
55-64	18.5 (319)	17.6 (15.2-20.2)	639.989
Education level			
Low (≤ 9 years)	47.1 (812)	45.2 (40.8-49.6)	1.641.155
Middle (12 years)	27.0 (466)	27.9 (24.8-31.2)	1.014.245
High (> 12 years)	25.8 (444)	26.9 (23.1-31.2)	978.259
Working condition			
Worker	69.4 (1197)	70.9 (67.5-70.4)	2.578.295
Unemployed	13.5 (232)	14.2 (11.8-16.9)	516.099
Other	17.1 (295)	14.9 (12.6-17.5)	542.143
Marital Status			
Married or common-law marriage	33.7 (581)	59.6 (56.2-62.9)	2.166.826
Single	35.7 (616)	30.9 (28.2-33.7)	1.124.643
Other	30.6 (527)	9.5 (7.5-11.9)	345.068
Household income			
Low (1st tercile)	33.7 (581)	31.2 (27.6-35.0)	1.133.405
Middle (2nd tercile)	35.7 (616)	35.1 (31.7-38.6)	1.276.262
High (3rd tercile)	30.6 (527)	33.7 (29.7-38.0)	1.226.870
Household size (MD±SD)	3.1±1.3	3.1±1.3 (3.02-3.24)	
Physical activity[1]			
Physically inactive (IPAQ low category)	57.9 (998)	57.3 (52.4-62.0)	2.082.555
Physically active (IPAQ high category)	42.1 (726)	42.7 (38.0-47.6)	1.553.981
Sitting time[2]			
Low sit (≤180min/day)	46.8 (806)	46.6 (42.3-51.0)	1.694.015
High sit (≥360 min/day)	53.2 (918)	53.4 (49.0-57.7)	1.942.521
Physical activity – Sitting time groups			
High PA/Low sit	26.3 (454)	26.6 (22.5, 31.1)	966.341
High PA/High sit	15.8 (272)	16.2 (13.8, 18.8)	587.641
Low PA / Low sit	20.4 (352)	20.0 (16.9, 23.5)	727.675
Low PA / High sit	37.5 (646)	37.3 (33.0, 41.7)	1.354.881
Total	100.0 (1724)	100.0 (3.636.538)	

Abbreviations: M, Mean; SD, Standard deviation; n, sample size; $\widehat{N}$, weighted population size; IPAQ, international physical activity questionnaire; PA, physical activity.

Notes:

[1]Physically inactive, low category of IPAQ; Physically active, high category of IPAQ; Percentage calculated without considering the participants classified in the moderately active category of IPAQ (n=916).

[2]Low Sitting, 1st tercile of sitting time (≤180min/day); High sitting (≥360 min/day), 3rd tercile of sitting time. Percentage calculated without considering the participants classified in the 2nd tercile of ST (n= 885).

Table 2 shows that the socio-demographic characteristics of the adults in each PA-ST group were significantly different ($p < 0.05$) concerning sex, age, education, marital status and household income. Compared to the other groups, the high PA/high sit group had a higher percentage of adults that were male (67.2%; $p = 0.04$), belonged to the two younger age group categories (54.3%; $p < 0.01$) and were single (53.6%; $p < 0.01$). The high PA/low sit and the low PA/high sit groups had a majority of adults from middle age groups' categories. The majority of participants from the high PA/low sit and low PA/low sit groups had a low education level and household income. Conversely, a higher percentage of participants from the other two 'high sit' groups had middle or high education level ($p <0.001$), and a high household income ($p < 0.01$).

Table 2. Weighted estimates of the socio-demographic characteristics of adults in each physical activity – sitting group.

	High PA / Low sit Weighted % (95% CI)	**High PA / High sit** Weighted % (95% CI)	**Low PA / Low sit** Weighted % (95% CI)	**Low PA / High sit** Weighted % (95% CI)	***p***
Sex[1]					0.004
Female	48.3 (42.6-54.0)	32.8 (26.9-40.3)	50.2 (43.6-56.8)	48.0 (42.8-53.3)	
Male	51.7 (46.0-57.4)	67.2 (59.7-74.0)	49.8 (43.2-56.4)	52.0 (46.7-57.2)	
Age[1]					<0.001
18-24	8.1 (5.2-12.3)	24.1 (17.5-32.4)	5.1 (2.8-9.1)	16.5 (12.3-21.7)	
25-34	17.8 (13.4-23.2)	30.2 (22.9-38.7)	11.9 (7.4-18.6)	13.9 (10.6-18.2)	
35-44	34.5 (29.3-40.1)	20.8 (14.4-29.1)	30.6 (23.9-38.2)	23.7 (19.6-28.3)	
45-54	20.9 (15.4-27.6)	15.5 (10.0-23.2)	29.2 (22.4-37.1)	28.6 (23.4-34.3)	
55-64	18.8 (14.5-24.0)	9.3 (5.4-15.6)	23.2 (17.0-30.8)	17.3 (13.9-21.4)	
Education level[1]					<0.001
Low (≤ 9 years)	59.8 (52.2-67.0)	29.3 (29.9-39.5)	61.7 (53.3-69.5)	32.7 (27.3-38.7)	
Middle (12 years)	22.6 (17.2-29.0)	28.9 (22.0-36.9)	22.2 (16.4-29.4)	34.3 (29.0-40.1)	
High (> 12 years)	17.6 (12.7-23.9)	41.7 (31.8-52.4)	16.1 (11.2-22.4)	33.0 (26.8-39.7)	
Working condition[1]					0.467
Worker	71.8 (63.5-78.9)	72.0 (63.0-79.5)	69.2 (61.0-76.4)	70.7 (65.9-75.0)	
Unemployed	14.4 (9.9-20.6)	13.7 (8.6-21.1)	18.7 (13.0-26.2)	11.8 (8.4-16.4)	
Other	13.7 (9.1-20.1)	14.4 (9.2-21.8)	12.1 (8.4-17.0)	17.5 (13.9-21.8)	
Marital Status[1]					<0.001
Married or common-law	64.1 (57.7-70.0)	40.6 (32.5-49.3)	68.9 (61.1-75.8)	59.6 (53.8-65.1)	
Single	26.0 (20.9-31.9)	53.6 (44.8-62.2)	17.4 (12.2-24.2)	31.8 (27.1-37.0)	
Other	9.9 (6.3-15.2)	5.8 (3.2-10.1)	13.7 (8.4-21.6)	8.6 (6.1-11.9)	
Household income[1]					<0.001
Low (1st tercile)	39.3 (31.2-48.0)	21.3 (14.9-29.3)	41.5 (33.6-49.8)	24.1 (19.8-29.0)	
Middle (2nd tercile)	33.8 (27.6-40.5)	34.4 (26.5-43.2)	34.6 (27.6-42.2)	36.7 (31.8-41.7)	
High (3rd tercile)	26.9 (19.8-35.5)	44.4 (36.5-52.6)	24.0 (17.6-31.8)	39.2 (33.3-45.6)	
Household size (M±SD)[2]	3.2±0.1 (3.0-3.4)	3.2±0.1 (3.0-3.4)	3.1±0.2 (2.9-3.3)	3.1±0.1 (3.0-3.2)	0.738

Abbreviations: PA, physical activity; M, Mean; SD, Standard deviation; n, sample size; $\widehat{N}$, weighted population size;

Notes: Physically inactive, low category of IPAQ; Physically active, high category of IPAQ; Low Sitting, 1st tercile of sitting time (≤180min/day); High sitting (≥360 min/day), 3rd tercile.

[1] Tested with one-way ANOVA in SPSS complex samples.

[2] Tested with Chi Square test in SPSS complex samples. Significance is based on the adjusted F and its degrees of freedom.

Table 3 presents the results from the binary logistic regression models examining the association of socio-demographic characteristics with belonging to higher categories of PA and of ST. The unadjusted analysis shown that adults who had 25-34 years old (OR = 1.90, 95% CI: 1.29-2.80) and 45-54 years (OR = 0.58, 95% CI: 0.42-0.80) were, respectively, more and less likely to be physically active, when compared with 18-24 year old adults. These results remained significant in the adjusted analysis. Compared to being married, being single was also associated with a higher level of PA in the non-adjusted (OR = 1.57, 95% CI: 1.15-2.13) and adjusted models (OR = 1.48, 1.07-2.07). Adults who had 35-44 years (OR = 1.66, 95% CI: 1.16-2.36) and a middle education level (OR = 0.642, 95% CI: 0.45-0.92) were respectively more and less likely to be physically active, but only after adjusting for other socio-demographic variables.

Additionally, table 3 presents the unadjusted and the adjusted analysis of socio-demographic factors associated with spending more than 360 minutes per day in ST. The unadjusted analysis shows that adults who had 35-44 years (OR = 0.61, 95% CI: 0.45-0.81) and 55-64 years (OR = 0.67, 95% CI: 0.48-0.94) had lower odds of being in the higher ST category, when compared to adults with 18-24 years. Conversely, adults who had middle or a high education level (OR = 1.68, 95% CI: 1.21-2.33), had a higher household income (OR = 2.00, 95% CI: 1.44-2.78) and were single (OR = 2.17, 95% CI: 1.56-3.01) had higher odds of spending more than 360 minutes per day in ST. All these factors remained significant in the adjusted model. Adults who had 44-55 years old (OR = 0.45, 95% CI: 0.25-0.80) and those who had a middle household income (OR = 1.64, 95% CI: 1.12-1.35) were, respectively, less and more likely to spend more than 360 minutes of ST daily, but these associations were only significant in the adjusted analysis.

Table 3. Potential weighted socio-demographic correlates of high physical activity and of high sitting time.

	High Physical activity[a]		High Sitting time[b]	
	Model 1 (Unadjusted) OR (95% CI)	**Model 2 (Adjusted) OR (95% CI)**	**Model 1 (Unadjusted) OR (95% CI)**	**Model 2 (Adjusted) OR (95% CI)**
Sex				
Male	1.30 (1.00-1.68)	1.25 (0.95-1.65)	1.26 (0.97-1.63)	1.31 (0.99-1.73)
Age				
18-24 (ref.)	Ref.	Ref.	Ref.	Ref.
25-34	1.90 (1.29-2.80)**	1.81 (1.20-2.73)*	1.29 (0.85-1.96)	0.64 (0.35-1.14)
35-44	1.17 (0.85-1.61)	1.66 (1.16-2.36) *	0.61 (0.45-0.81)**	0.41 (0.27-0.61)***
45-54	0.58 (0.42-0.80)**	0.65 (0.47-0.91)*	1.01 (0.704-1.45)	0.45 (0.25-0.80)*
55-64	0.75 (0.55-1.02)	0.81 (0.55-1.20)	0.67 (0.48-0.94)*	0.62 (0.41-0.94)*
Education level				
Low (≤ 9 years) (ref.)	Ref.	Ref.	Ref.	Ref.
Middle (12 years)	0.77 (0.56-1.07)	0.642 (0.45-0.92)*	1.68 (1.21-2.33)*	2.70 (1.87-3.89)***
High (> 12 years)	0.99 (0.681.43)	0.73 (0.50-1.08)	2.71 (1.89-3.88)***	3.67 (2.19-6.15)***
Working condition				
Worker (reference)	Ref.	Ref.	Ref.	Ref.
Unemployed	0.99 (0.65-1.52)	0.87 (0.56-1.35)	0.73 (0.48-1.10)	0.90 (0.56-1.46)
Other	0.88 (0.59-1.32)	0.85 (0.55-1.29)	1.33 (0.87-2.01)	1.53 (0.99-2.38)
Marital status				
Married or common-law (ref.)	Ref.	Ref.	Ref.	Ref.
Single	1.57 (1.15-2.13)*	1.48 (1.07-2.07) *	2.17 (1.56-3.01)***	1.67 (1.12-2.49)*
Other	0.78 (0.47-1.32)	0.952 (0.53-1.69)	0.64 (0.41-1.02)	0.72 (0.39-1.35)
Household income				
Low (1st tercile) (ref.)	Ref.	Ref.	Ref.	Ref.
Middle (2nd tercile)	0.92 (0.68-1.24)	0.91 (0.65-1.28)	1.09 (0.84-1.41)	1.64 (1.12-2.40)*
High (3rd tercile)	0.98 (0.70-1.39)	1.08 (0.74-1.58)	2.00 (1.44-2.78)***	1.84 (1.16-2.91)*
Household size	0.94 (0.85-1.05)	0.92 (0.83-1.02)	0.99 (0.89-1.12)	1.09 (0.95-1.25)

Abbreviations: M, Mean; SD, Standard deviation; OR odds ratio, CI, confidence interval.
Notes:
[a] Physically active, high category of IPAQ, is the reference category.
Model 1: Unadjusted analyses.
Model 2: Adjusted for variables where $p < 0.2$ (sex; age 25-34; education 12 years and >12; and marital status single).
[b] High sitting (≥360 min/day), 3rd tercile of sitting time, is the reference category.
Model 1: Unadjusted analyses;
Model 2: Adjusted for variables with $p < 0.2$ (sex; age 25-34, 35-44, 55-64; education 12 years and >12; household income 2nd and 3rd terciles; and household size).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In table 4, the observed socio-demographic associations with each PA-ST group are presented. Adults who had 35-44 years old had higher odds of being in the high PA/low sit group when compared to younger adults, either in the unadjusted (OR = 1.58, 95% CI: 1.16-2.17) and adjusted (OR = 2.10, 95% CI: 1.42-3.10) models. Adults with middle or a high education had lower odds of belonging to this group, in both models. Being single was significantly and inversely related with belonging to the high PA/low sit group, but only in the unadjusted model (OR = 0.72, 95% CI: 0.53-0.99). Conversely, adults who had 25-34 years old were significantly and positively related with this group only in the adjusted model (OR = 1.83, 95% CI: 1.08-3.10).

Concerning the high PA/high ST group, in the unadjusted (cf. table 4) and adjusted models, adults who were male (OR = 1.96, 95% CI: 1.33-2.90), highly educated (OR = 1.86, 95% CI: 1.14-3.03) had higher odds of belonging to this group. Those with 45-54 (OR = 0.52, 95% CI: 0.29-0.91) and 55-64 (OR = 0.38, 95% CI: 0.15-0.93) years old had lower odds. Adults who had 35-44 years were less likely to belonging to this group, compared to those with 18-24 years, only in the adjusted model (OR = 0.51, 95% CI: 0.61-1.97). Some other socio-demographic variables did not remain significant in the adjusted model: having between 25 and 34 years (OR = 1.10, 95% CI: 0.61-1.97), having high household income (OR = 1.41, 95% CI: 0.99-2.01) and being single (OR = 1.77, 95% CI: 0.93-3.337).

As for the low PA/low sit group, in the unadjusted (cf. table 4) and adjusted models, adults who had a higher education level (OR = 0.46, 95% CI: 0.27-0.79) and were single (OR = 0.49, 95% CI: 0.29-0.84) were less likely to belong to this group. Having a higher household income did not remain significant in the adjusted model (OR = 0.69, 95% CI: 0.44-1.09).

Regarding the low PA/high sit group, adults who had middle (OR = 2.59, 95% CI: 1.76-3.84) or a high (OR = 2.58, 95% CI: 1.61-4.11) education were more likely to belong to this group, either in the unadjusted (cf. table 4) and adjusted models. Adults who had 25-34 years (OR = 0.46, 95% CI: 0.28-0.75) and 35-44 years (OR = 0.57, 95% CI: 0.39-0.84), and had middle household income (OR = 1.50, 95% CI: 1.07-2.11), had respectively lower and higher odds of belonging to this group, but only in the adjusted model. Adults from the higher household income category had higher odds of being in the low PA/high sit group, but only in the unadjusted model (OR = 1.47, 95% CI: 1.08-2.01).

Table 4. Potential weighted socio-demographic correlates of each physical activity – sitting group.

Characteristic	High PA / Low sit		High PA / High sit		Low PA / Low sit		Low PA / High sit	
	Model 1 (Unadjusted) OR (95% CI)	Model 2 (Adjusted) OR (95% CI)	Model 1 (Unadjusted) OR (95% CI)	Model 2 (Adjusted) OR (95% CI)	Model 1 (Unadjusted) OR (95% CI)	Model 2 (Adjusted) OR (95% CI)	Model 1 (Unadjusted) OR (95% CI)	Model 2 (Adjusted) OR (95% CI)
Sex								
Male	0.89 (0.67-1.18)	0.87 (0.65-1.16)	1.94 (1.34-2.82)**	1.96 (1.33-2.90)*	0.81 (0.59-1.12)	0.84 (0.61-1.18)	0.88 (0.68-1.15)	0.89 (0.68-1.18)
Age								
18-24 (reference)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
25-34	1.06 (0.70-1.61)	1.83 (1.08-3.10)*	2.52 (1.58-4.00)***	1.10 (0.61-1.97)	0.60 (0.34-1.04)	0.94 (0.59-1.73)	0.69 (0.46-1.03)	0.46 (0.28-0.75)*
35-44	1.58 (1.16-2.17)*	2.10 (1.42-3.10)***	0.65 (0.41-1.03)	0.51 (0.27-0.97)*	1.21 (0.86-1.71)	1.18 (0.81-1.72)	0.74 (0.53-1.02)	0.57 (0.39-0.84)*
45-54	0.76 (0.50-1.15)	0.94 (0.60-1.48)	0.52 (0.29-0.91)*	0.43 (0.21-0.90)*	1.35 (0.91-2.01)	1.49 (0.81-2.74)	1.41 (1.00-1.98)	1.30 (0.85-1.95)
55-64	1.12 (0.79-1.59)	1.27 (0.81-1.99)	0.43 (0.23-0.80)**	0.38 (0.15-0.93)*	1.56 (0.97-2.51)	1.16 (0.70-1.92)	0.971 (0.704-1.34)	0.84 (0.56-1.28)
Education level								
Low (≤ 9 years) (reference)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Middle (12 years)	0.69 (0.47-0.99)*	0.44 (0.31-0.64)***	1.06 (0.72-1.56)	1.21 (0.74-1.98)	0.69 (0.45-1.06)	0.61 (0.36-1.02)	1.65 (1.19-2.28)*	2.59 (1.76-3.84)***
High (> 12 years)	0.49 (0.31-0.79)*	0.32 (0.19-0.56)***	2.26 (1.43-3.59)**	1.86 (1.14-3.03)*	0.45 (0.30-0.68)***	0.46 (0.27-0.79)*	1.62 (1.16-2.26)*	2.58 (1.61-4.11) ***
Working condition								
Worker (reference)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Unemployed	1.03 (0.61-1.71)	0.92 (0.54-1.55)	0.95 (0.53-1.71)	0.89 (0.49-1.59)	1.53 (0.87-2.69)	1.60 (0.90-2.85)	0.73 (0.50-1.07)	0.90 (0.59-1.35)
Other	0.88 (0.52-1.50)	0.96 (0.59-1.66)	0.95 (0.54-1.67)	0.74 (0.41-1.32)	0.74 (0.48-1.14)	0.71 (0.44-1.12)	1.38 (0.97-1.95)	1.29 (0.92-1.82)
Marital Status								
Married (reference)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Single	0.72 (0.53-0.99)*	0.86 (0.54-1.26)	3.20 (2.13-4.79)***	1.77 (0.93-3.37)	0.40 (0.25-0.65)***	0.49 (0.29-0.84)*	1.07 (0.77-1.49)	0.91 (0.60-1.35)

Table 4. Potential weighted socio-demographic correlates of each physical activity – sitting group (Continuation)

	High PA / Low sit		High PA / High sit		Low PA / Low sit		Low PA / High sit	
	Model 1 (Unadjusted) OR (95% CI)	**Model 2 (Adjusted) OR (95% CI)**	**Model 1 (Unadjusted) OR (95% CI)**	**Model 2 (Adjusted) OR (95% CI)**	**Model 1 (Unadjusted) OR (95% CI)**	**Model 2 (Adjusted) OR (95% CI)**	**Model 1 (Unadjusted) OR (95% CI)**	**Model 2 (Adjusted) OR (95% CI)**
Other	1.06 (0.60-1.87)	1.01 (0.52-1.87)	0.54 (0.28-1.03)	1.24 (0.61-2.48)	1.72 (0.94-3.12)	1.24 (0.64-2.38)	0.84 (0.51-1.39)	0.80 (0.43-1.50)
Household income								
Low (1st tercile) (reference)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Middle (2nd tercile)	0.92 (0.66-1.29)	0.83 (0.57-1.18)	0.96 (0.65-1.42)	1.34 (0.77-2.41)	0.97 (0.67-1.39)	0.72 (0.45-1.13)	1.12 (0.86-1.44)	1.50 (1.07-2.11)*
High (3rd tercile)	0.65 (0.42-1.01)	0.77 (0.44-1.34)	1.72 (1.20-2.47)*	1.41 (0.99-2.01)	0.56 (0.38-0.82)*	0.69 (0.44-1.09)	1.47 (1.08-2.01)*	1.41 (0.93-2.13)
Household size	0.96 (0.85-1.09)	0.96 (0.85-1.09)	0.95 (0.81-1.12)	1.02 (0.87-1.21)	1.05 (0.90-1.23)	1.03 (0.84-1.26)	1.03 (0.91-1.15)	1.08 (0.94-1.24)

Abbreviations: PA, physical activity; OR, odds ratio; CI, confidence interval;

Notes:

Physically inactive, low category of IPAQ; Physically active, high category of IPAQ; Low Sitting, 1st tercile of sitting time (≤180min/day); High sitting (≥360 min/day), 3rd tercile of sitting time.

Model 1: unadjusted.

Active/Low sit, Model 2: adjusted for socio-demographic variables with $p < 0.2$ (age: 25-34 and 35-44; education 12 years and >12; household income: 2nd tercile).

Active/High sit, Model 2: adjusted for socio-demographic variables with $p < 0.2$ (sex; age: 35-44, 45-54, 55-64; education >12 years; marital status single; household income 3rd tercile).

Inactive/Low sit: Model 2: adjusted for socio-demographic variables with $p < 0.2$ (age: 35-44, 55-64; education 12 years and >12 years; marital status single; household income 3rd tercile).

Inactive/High sit: Model 2: adjusted for socio-demographic variables with $p < 0.2$ (age: 25-34, 35-44; education 12 years and >12 years; working condition other; marital status single; household income 2nd and 3rd tercile, household size)

*p < .05, **p < .01, ***p < .001

2.4. Discussion

The present study aimed to identify the population socio-demographic profile associated with PA and ST, as well as with the combination of these two behaviors dimensions. Main results show that a relatively large proportion of Portuguese adults (37.5%) had a 'higher risk' profile characterized by low PA and high ST behaviours. However, about one in four adults were in the 'lower risk' group (high PA/low ST). Specific correlates of PA and ST were identified, but a novel aspect of the present study was the identification of the diverse socio-demographic correlates for each specific PA/ST group.

2.4.1. Prevalence and socio-demographic factors associated with the physical activity

The prevalence of adults classified in the low, moderate and high categories of IPAQ were 40.7%, 28.2% and 31.1%. If the "moderate" and "high" categories are taken together, the percentage of adults who are physically inactive (40.7%) is relatively similar to the percentages found in other population-based studies conducted in Portugal and elsewhere, using self-reported PA (between ~23% and ~41%) (Guthold et al., 2018; A. Marques, Martins, Peralta, Catunda, & Nunes, 2016; A. Marques et al., 2015; Sallis et al., 2016), or objectively measured PA (Baptista et al., 2012). However, it is important to acknowledge that only adults classified in the "low" and "high" categories of IPAQ were included in the analysis. This methodological option allowed having a clearer contrast between the distinct PA-ST groups, in order to compare more distinct PA and ST levels.

Being physically active (high category of IPAQ), as opposed to being inactive (low category of IPAQ), was positively associated with having between 25 and 44 years of age, and inversely related with having 45-55 years. This is in line with previous studies that

suggest the existence of an inverse relationship of PA with age (Bauman et al., 2009; Bauman et al., 2012). This could be due to people with age might get involved in more light intensity PA as opposed to moderate to vigorous PA (MVPA) intensity (Ayabe et al., 2009). Moreover, changes in employment status, residence, physical status, and relationship or in family structure have been identified as critical for reducing PA level of adults (Allender, Hutchinson, & Foster, 2008). These results also suggest that adults aged 25-44 are more active than those aged 18-24. Previous studies show that the transition from adolescence to adulthood is a critical moment where individuals face major transitions in their lives, such as going to university or getting a job, and where their PA levels are low or decline (Enberg et al., 2012; Pengpid et al., 2015).

The correlation between education level and PA is not fully understood. Some studies found positive associations (Bauman et al., 2012) whereas others found no or inverse associations (A. Marques, Martins, et al., 2016). In the current study, having a middle educational level was negatively related to being physically active. As the short form of the IPAQ considers the overall PA levels and not the diverse PA types (e.g. leisure, occupational), it might be that those with a lower educational background have more occupational related PA (O'Donoghue et al., 2018). Mixed evidences also exist concerning the relationship between socioeconomic status and PA (O'Donoghue et al., 2018), and in this study no relationship was found. Moreover, men tended to be more active than women but the difference did not reach statistically significance as in other studies (Bauman et al., 2012; Guthold et al., 2018; Sallis et al., 2016).

2.4.2. Prevalence and socio-demographic factors associated with the sitting time

Currently, evidence is not sufficiently developed to define a meaningful sitting threshold associated with health outcomes (Stamatakis et al., 2018; USDHHS, 2018).

Hence, when defining ‘low’ or ‘high’ categories of ST researchers have adopted different strategies, namely: based on quartiles (Engelen et al., 2017), terciles (Rosenberg et al., 2008), median values (Maddison et al., 2016) and other composite strategies (Bakrania et al., 2016; Bennie et al., 2013; Loprinzi et al., 2014). In this study, it was first found that 36% of the adults spend 180 minutes or less in ST (low), 25.3% spend between 181 and 359 minutes, and 38.7% more than 380 minutes.

In a recent literature review of international studies it was found that, based on self-reported estimates, ST is high in adults from high-income countries and about 33% reported sitting more than 7-8 hours per day, which is relatively similar to our results (Bauman et al., 2018). However, the same study shows that self-reports may underestimate ST by a relative large margin when compared with objective methods. Thus, from a public health perspective, and by taking into account the detrimental health outcomes of ST on health (Biswas & Alter, 2015; Chau et al., 2013), it is fundamental to identify socio-demographic factors of those individuals with high ST.

Based on the adjusted model, being younger (18-24 years), single, and having both a middle/high educational and socioeconomic background was positively associated with a high ST. The inverse associations between age and ST are consistent with previous large-scale studies using similar self-report measures (Bauman et al., 2011; Bennie et al., 2013; Bennie et al., 2016). In a recent nationally representative sample where ST was objectively measured it was identified that the transition from adolescence is a critical moment concerning ST, and that ST remained relatively stable throughout adulthood (Santos et al., 2018). The higher ST rates of younger adults might be due to a large proportion of this group being a student (Loyen, van der Ploeg, et al., 2016). Other reasons might be related to the tracking of ST from adolescence to adulthood (Biddle, Pearson, Ross, &

Braithwaite, 2010) and the high computer and internet usage of younger adults (Lakerveld et al., 2017; O'Donoghue et al., 2018).

People with higher education levels and a higher socioeconomic status have also been consistently identified as spending high overall ST (Bauman et al., 2018; Bennie et al., 2016; Loyen, van der Ploeg, et al., 2016; O'Donoghue et al., 2018), which might be related to their sedentary occupations. The evidence concerning the marital status is inconclusive (Bauman et al., 2018), but in this study being single was associated with higher odds of belonging to high ST category. Moreover, gender was not related with ST. Previous studies found mixed results, with some studies finding no relation (Bauman et al., 2011; Lakerveld et al., 2017) and others suggesting that females spend less time in a sitting behaviour (Loyen, van der Ploeg, et al., 2016).

2.4.3. Factors associated with PA/ST patterns

As for the PA/ST patterns, low PA/high ST adults comprised 37.5% of the sample. In the adjusted model, having middle and high educational level, as well as a middle socioeconomic position, was positively related with belonging to this group. More educated adults, and those with a higher socioeconomic position, were classified more frequently in the low PA/high ST group in some studies (Bennie et al., 2013; Omorou, Coste, Escalon, & Vuillemin, 2016), but not in others (Engelen et al., 2017; Loyen et al., 2017; Maddison et al., 2016), possibly due to high sit at work. In our study, having between 25 and 44 years old was inversely related to belonging to the 'higher risk' group. While in one-study adults were aged 25-44 years (Bennie et al., 2016), which contradicts our findings, in other studies they were older (Engelen et al., 2017; Loyen, Verloigne, et al., 2016; Maddison et al., 2016). Overall, messages to promote PA and reduce ST might be directed to younger (18-24) and older adults (>45) with a middle/high education and

socioeconomic background. Nevertheless, further studies on these and other additional correlates of PA/ST patterns are needed to test and extend these findings.

Being middle aged and having a low educational level characterized the 'lower risk' group (high PA/low ST). In other studies, being younger (Engelen et al., 2017; Maddison et al., 2016), male (Maddison et al., 2016; USDHHS, 2018), and having a lower socioeconomic status and educational level (Bennie et al., 2013; Omorou et al., 2016) was positively associated with belonging to this group. High PA levels might be related with occupational PA (Engelen et al., 2017; Omorou et al., 2016). However, evidence shows that the health benefits of PA are mainly related with leisure time PA or active commuting (e.g. cycling or walking to work), rather than global expenditure. Indeed, occupational work can be associated with detrimental health outcomes (Coenen et al., 2018; Holtermann, Krause, van der Beek, & Straker, 2018). To better understand and explore this phenomenon, further studies should collect information on the type of job and on the diverse types of PA.

Being male, younger adult (25-44 years) and having a high educational level was associated with greater odds of being in the high PA/high ST group, which is consistent with previous studies (Engelen et al., 2017; Maddison et al., 2016). These adults might have a desk job and accumulate a lot of sedentary behaviour throughout the day but at the same time meet the MVPA guidelines (WHO, 2010). For this group, tailored messages and interventions at work for reducing ST might be needed.

More than 12 years of education and being single was associated with lower odds of belonging to the low PA/low ST group. In the literature, this group has been characterized by many distinct variables, such as being female (Maddison et al., 2016), older adult (Engelen et al., 2017), students or retired persons (Omorou et al., 2016). Due to the divergences across studies more evidence is needed.

2.4.4. Strengths, limitations and future implications

This study has several strengths and limitations. The use of a large and representative sample allowed having an adequate statistical power with external validity. The data collection methods, with direct interviews being applied by trained health personal, associated with the use of valid, reliable and internationally comparable instruments to measure PA and ST (Bauman et al., 2011; Craig et al., 2003; P. Lee et al., 2011) were other important strengths. However, it is well known that self-reported PA and ST tended to be, respectively, overestimated and underestimated by participants (Bauman et al., 2018; Craig et al., 2003; A. Marques et al., 2014). Nevertheless, values of PA were found to be relatively similar with other studies in national context (Bauman et al., 2011; Loyen, van der Ploeg, et al., 2016). Moreover, the cross-sectional design does not allow causal inferences to be made, and to understand whether the groups and their correlates were stable over time. Thus, future research should include longitudinal designs and collect objective PA/ST data. Future studies should also move beyond socio-demographic factors (e.g. psychosocial and environmental variables) of combined patterns of PA/ST and consider the relationship of each PA-ST profile with health. Moreover, considering the relevance that the professional occupation might have for the amount of time spent in PA and ST by adults (e.g. white-collar workers, blue-collar workers), future studies should collect information on this data.

From a public health and preventive perspective, future messages and interventions might need to be tailored to specific profiles of PA/ST, rather than just considering PA or ST in isolation. An important initial strategy for the 'high risk' group (low PA/high ST) might be to encourage the adoption of light intensity PA and break ST, since it might be more amenable to change when compared to MVPA. Messages to the high PA/high ST group might be focused on reducing ST, and moving more at light intensities. Since, adults

spent a large part of their daily waking time in a labour context or in a university context, interventions might need to be implemented in these contexts, as well as in leisure and active commuting contexts.

2.5. Conclusion

This study is the first to have examined the socio-demographic factors associated with the combined patterns of PA and ST in a representative sample of Portuguese adults. The 'higher risk' group (low PA/high ST) represented almost 40% of the sample, highlighting the need to promote PA and limit ST at a population level. Adults aged 18-24 years and over 44 years, and people with 12 or more years of education, were more likely to be classified in this 'higher risk' group. Given the identified relevance of this combined approach of PA and ST, public health and promotion strategies, interventions and policies may need to be tailored to specific profiles of PA/ST.

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